International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Performance of Sorghum/Soyabean Intercrop as Influenced by Cultivar and Row Arrangement in the Northern Guinea Savanna Vegetational Belt of Nigeria.

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Abstract

Field trials were conducted at the Institute for Agricultural Research (IAR) farm, Samaru, Zaria during the 2008 - 2010 rain-fed seasons to study the performance of sorghum/soyabean intercrop as influenced by cultivar and row arrangement. The treatments tested were made up of two sorghum cultivars (SAMSORG-14 and SAMSORG-17), two soyabean cultivars (TGx 1448-2E and SAMSOY 2) and four crop row arrangements (1SG:1SY, 1SG:2SY, 2SG:1SY and 2SG:2SY, of sorghum : soyabean rows) in factorial combinations. The treatments were arranged in a randomized complete block design and replicated three times. SAMSORG-14 was more aggressive in growth than SAMSORG-17. Among the treatment combinations, SAMSORG-17 intercropped with TGx 1448-2E in 2SG:1SY row arrangement had the highest (0.28) aggressivity followed by SAMSORG-17 intercropped with TGx 1448-2E in 1SG:1SY row arrangement (0.05). For sorghum, SAMSORG-14 intercropped with TGx 1448-2E in 2SG:1SY row arrangement was the most competitive (4.6). However, for soyabean, competitive ability was highest when TGx 1448-2E was intercropped with SAMSORG-17 in 1SG:2SY row arrangement (2.24). All but one intercrop had LER values above unity, suggesting a considerable benefit for intercropping sorghum with soyabean. Among the treatment combinations, SAMSORG-17 intercropped with TGx 1448-2E in 1SG:1SY row arrangement produced the highest LER value of 1.40.

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This study has shown that the productivity of sorghum/soyabean cultivar(s) were most enhanced in 1SG:1SY and 1SG:2SY row arrangements and they could therefore be recommended for the northern Guinea savanna.

Keywords: Aggressivity; Relative competitive ability; LER.

1. Introduction

Sorghum (Sorghum bicolor (L.) Moench) is a crop of worldwide importance [1]. The crop is widely cultivated in the savanna ecological areas of Nigeria [2, 3, 4, 5]. Many workers [6, 7, 8, 9] have reported that cereal-based intercropping systems are predominant in northern Nigeria. It was further noted that pearl millet and sorghum are the major cereals intercropped with each other and with some legumes, namely, cowpea and groundnut in various proportions and arrangements. The dominant crop mixtures that have been reported in the literature include millet / cowpea, millet / sorghum / cowpea, millet / cowpea / groundnut and sorghum / cowpea [8, 10, 9]. Sorghum/millet/cowpea was the single most widespread intercropping practice in the Nigerian savannah [4]. Nigeria is the third world largest producer of sorghum after United States of America (USA) and India while at the regional level, sub-Saharan Africa is the largest producer and also the largest consumer [11].

Intercropping is popular among small-scale farmers in tropical and sub-tropical environments [12]. One of the most important reasons to grow two or more crops together is the increase in productivity per area of land [13]. There are several criteria to be satisfied in evaluating intercrop experiments, namely, usefulness to the farmer (like crude protein, calories, fat), intercrop competitiveness, yield and land use complementarity[14,15]. The biological efficiency of intercropping is determined by comparing the productivity of a given land area under intercropping with productivity if the same land area were to be divided between the sole crops to give the same ratios of the two crops as in intercropping[16] . Crop complementarity of an intercrop may be considered to occur when the intercrop yields are more than the yields obtained from an equivalent land area planted in monoculture [14]. The most important index of biological advantage is the introduced relative yield total (RYT)[17] or land equivalent ratio (LER)[18]. The index is based on relating the yield of each crop in an intercrop treatment mixture to be the yield of that crop grown as a sole crop.

LER is defined as the relative land area required as sole crop to produce the same yields as intercropping [19,16]. LER provides standardized basis so that crops can be added to form combined yields. Comparison between individual LERs (LA and LB) can indicate competitive effects. Furthermore, of primary importance, the total LER can be taken as a measure of the yield advantage. For instance, LER of 1.2 indicates a yield advantage of 20 percent (or strictly speaking that 20 percent more land would be required as sole crops to produce the same yield as intercropping).

It was reported that maize/soyabean intercropping system gave a more efficient land use efficiency than pure stands [20]. Furthermore, maximum LER values of 1.47 and 1.77 calculated in the 1:2 spatial arrangement were due to nitrogen fertilization. The total LER values for both crops (millet:cowpea) was observed to be greater than 1.00 and the LER and gross returns of crop in the within-row arrangement exceeded those in the row arrangement by 13.6 and 12 percent, respectively[21].

LER which varied from 1.20 to 1.57 increased as the difference in the maturity period of sorghum and soyabean increased [22]. The highest LER was obtained in soyabean and maize intercrop that received the highest fertilizer rate (300 kg NPK)[23]. The LER was 31 to 68 percent in 2002 and 55 to 77 percent in 2003. In a study of the effect of plant density of intercropped soyabean with tall sorghum on competitive ability of soyabean and economic yield in the southern Guinea savanna agro-ecology of Nigeria, it was observed that all the intercrop combinations had LER varying from 1.63-1.97. The LER values decreased with increasing soyabean density [24].

Aggressivity and competitive ratio are competitive indices of dominance [26,26]. Aggressivity attempts to measure the between or intercrop competition [18]. The Competitive ability of the component crops in a sorghum-cowpea intercropping systems was determined by its aggressivity value [27]. Regardless of the planting patterns, there was a positive sign for sorghum and a negative sign for intercropped cowpea indicating that sorghum was more dominant while cowpea was dominated. Furthermore, results showed positive values for sorghum under 2S:1C and 1S:1C planting patterns while it proved less competitive and was dominated by cowpea under 1S:2C planting pattern. Aggressivity index from studies on sorghum/alfalfa intercropping indicated that alfalfa and sorghum in the first year were suppressed and dominated respectively while in the second year, sorghum domination decreased as its proportion in the intercropping system increased [28]. Result from an investigation on the effect of plant density of intercropped soyabean on tall sorghum, showed that aggressivity values were consistently negative at soyabean population of 200,000 plants per hectare with a mean value of -0.25 and values were inconsistent at soyabean population of 333,000 and 400,000 plants per hectare [24].

Competitive ratio (CR) is referred to as the ratio of the individual LERs of the two component crops, but correcting for the proportion of which the crop were initially sown [26]. It is an index that is useful in comparing the competitive ability of different crop species and also identify which plant character is associated with competitive ability. It provides information as to the number of times one component crop is more competitive than the other crop [26].

The effect of planting pattern (within-row, alternate and mixed intercropping) on grain yield, dry matter production in wheat and bean (Vicia faba) showed that competitive ability with respect to wheat (CR) for dry matter was greater than one[29]. Also, CR for grain yield was greater than one. It was reported that competitive coefficient favoured maize when compared with soyabean component presumably because of the more competitive ability of maize-a taller and C4 plants with higher efficiency of light utilization than soyabean- a C3 plant growing under maize canopy [30]. In sorghum/cowpea intercrop, sorghum had higher competitive indices than cowpea in all the planting patterns except 1S:2C arrangement [27]. This results also corroborates those of aggressivity which showed that sorghum was more competitive than cowpea. CR of soyabean increased (0.76-1.15) with increasing density of the soyabean in the intercrop combinations indicating higher competitiveness at higher densities than the sorghum components [24].

Apart from the work by few researchers [22,31] , row arrangement has not been fully exploited in sorghum-soyabean intercropping system in the Nigerian savanna.

Comparatively, a lot of research has been carried out on cereal/cowpea mixtures. Research on cereal/cowpea intercrop has so advanced that in the 2003 cropping season, more than 900 farmers participated in the on-farm evaluation of “best bet” options, involving sorghum/cowpea in the Sudan savanna and maize/ dual-purpose cowpea in the northern Guinea Savanna[32]. Farmers were reported to obtain 100-300 percent increase in yields. Since intercropping is attractive and has enormous advantages to small-holder farmers in Nigeria and sub-Saharan Africa, it has become necessary to provide more suitable options in terms of planting pattern, cost, yield advantages and income. The need to identify sorghum/soyabean combinations for use in the various agro-ecological zones has become necessary in view of their low input requirements. This need is further emphasised by the fact that rain fall pattern in Nigeria in the past 30 years (1961-1990), is characterised by reduction in the length of the rainy season so much so that the period available for crop growth has been shortened by nearly one month due to delayed onset of rains. There is also a steady shift southwards of isohytets at an annual level, which makes it imperative to re-examine the crops being planted to avoid short-term benefits [33,34]. The International Water Management Institute has also warned that by the year 2025, 25 percent of the world’s population will experience severe water scarcity [11].

Earlier and more recent breeding efforts in Nigeria have increased the prospects of intercropping systems involving soyabean (Glycine max (L.) Merr)[35,32,36]. Majority of farmers grow soyabean in mixture with maize or sorghum [37,4]. Survey has also shown that more hectarages are used in soyabean-based mixture intercropping in Nigeria [36]. A systematic transect revealed high rates of adoption of IITA’s improved soyabean varieties in northern Nigeria [32].

In spite of the fact that some scientists have in the past made attempts to manipulate the agronomy of cereal/legume intercropping systems to better their productivity, recent global weather changes makes it imperative to re-examine some of the factors that influence the productivity of the intercropping systems. In view of the fact that new soyabean varieties have recently been released for production of farmers, the present investigation was therefore conducted to determine the effect of competitive indices and row arrangement on the performance of sorghum/soyabean intercropping system.

At very low levels of exposure in children (<10 µg/dl) it has been associated with higher absenteeism in school, poor vocabulary and grammatical reading scores, longer reaction time, poor hand-eye coordination and impaired growth [10]. It is also associated with reduced attention span [11]. The incomplete development of the blood-brain barrier in the foetus and every young child (up to 36 months of age) increases the risk of lead’s entry into the developing nervous system, which can result in prolonged or permanent neuro-behaviour disorders [12,13].

2. Material and Materials

Field trials were conducted during the rain-fed seasons of 2008, 2009 and 2010 at the Research Farm of the Institute for Agricultural Research (IAR) Samaru (11° 11'N, 07° 38'E; 686 m above sea level), Nigeria. Samaru lies in the northern Guinea savanna ecological zone with a long-term annual rainfall mean of about 1050 mm [38]. The rainfall is unimodal and concentrated almost entirely within a 5-month period of May to September thereby supporting crops with early to late growing cycles.

Before the commencement of the experiment, five soil samples were collected at random across the experimental field at a depth of 0-15 and 15-30cm with a soil auger. The composite soil sample taken after bulking was air-dried and ground to pass through a 1.00mm sieve and analysed in the laboratory for physico-chemical properties using standard procedures [39].

The row-intercropping trial involved two sorghum cultivars namely SAMSORG-14 (KSV-8) and SAMSORG-17 (K.S.V-3/SK-5912) with two soyabean cultivars (SAMSOY 2 and TGx-1448-2E), at four row arrangement patterns (1:1, 1:2, 2:1, and 2:2 SG:SY). The randomised complete block design, with three replications, was the experimental design adopted for the trial. Sole plots of each cultivar were also included with the recommended agronomic practices.

SAMSORG-14 released as K.S.V-8 by I.A.R, Samaru is a medium season crop with maturity period of 130-140 days. The crop has potential yield of 2500-3000 kg ha-1 and has a white seed colour [39]. The crop is tall (3.1m) and has fairly long open or loose elliptical head with large white grains and small tan glumes [41,22].

SAMSORG-17 was released by the I.A.R Samaru as K.S.V-3/SK-5912 [40]. The crop is long season, semi-tall and tolerant to striga. SAMSORG-17 heads in 130 days and matures between 170 and 175 days. The head is compact and elliptical with bold yellow grains surrounded with brown small glumes [41]. The crop has potential yield of 2500-3500 kg ha-1. Both cultivars are photo-sensitive [22].

SAMSOY 2 released as M216 by I.A.R Samaru in 1983, is a medium (115-129 days) maturing crop. The crop has high shattering resistance (less than 2 percent) and tolerant to endemic insects and pests [36]. It is short and stout with determinate growth habit and bears pods in clusters well above the ground. The seeds are large and yellow [41] with high yield potential of 1442-2000 kg ha-1 [43,36,44].

TGx 1448-2E was released in 1992 by National Cereal Research Institute, Badegi[45]. The crop is medium maturing (115-117 days) with a yield potential of 1584-1829 kg ha-1. TGx 1448-2E has high shattering resistance (less than 2 percent) and tolerant to endemic insect pests and diseases[46,43,47,44].

The experimental field was ploughed, harrowed and ridges were made at 75cm. The inter-row spacing was 75 cm while within row spacing were 25cm and 5cm for the sorghum and soyabean crops respectively. Sowing was done on 25th June, 2nd July and 3rd July in 2008, 2009, and 2010, respectively. The sowing was done manually and simultaneously. At about three weeks after sowing (WAS), the sorghum sole plots were thinned to one plant per hill while the intercrop was thinned to two plants per hill. The soyabean seeds were sown at 5cm on the ridge.

The gross plot size was 6 m x 7.5 m width (45 m2). The replicates were separated from the other by a two metre (2 m) border. Plots were also separated from each other by a one metre (1 m) border. The net plot comprised the six (6) centre rows with an area measuring 6 x 4.5 m (27 m2) for the sole, 1SG:1SY, 1SG:2SY, 2SG:1SY crop row arrangements, while the four (4) centre rows measuring 6 x 3m (18 m2) served as net plot for 2SG:2SY crop row arrangement.

Fertilizer was applied at the rates of 64 kgN and 14 kg P to the sorghum crop and 20 kgN and 26.2 kg P to the soyabean crop. Urea (46% N) and single superphosphate (18% P2O5) were used as sources of N and P respectively. Sorghum was side-dressed with equal halves of 64 kg N ha-1 at 3 and 6 WAS, while the phosphorus was applied at planting. The soyabean component received all the fertilizer by band application at sowing.

Hoe weeding was done at 3 WAS followed by remoulding at 6 WAS for both crops.

The net plot area was harvested when the sorghum heads and soyabean pods had attained physiological maturity. The harvested heads and pods were air-dried for 2 weeks before they were threshed.

The meteorological data of the experimental site for the three years (2008, 2009 and 2010) comprising temperature, rainfall and sunshine hours were collected from the IAR's Meteorological unit and are as shown in Appendix 1.

2.1. Land equivalent ratio (LER)

Land equivalent ratio was determined in order to quantify the land-use efficiency of the intercrop. It was calculated according to the formula shown below [16]:

$$LER = La + Lb = \frac{Y_{ab}}{Y_{aa}} + \frac{Y_{ba}}{Y_{bb}}$$

Where,

Yab, Yba = Yields of intercrop "a" in mixture with species "b" and intercrop "b" in mixture with species "a", respectively.

Yaa, Ybb = Corresponding sole crop yields of species a and species b, respectively.

The component and sole crop yields used in the calculation were the means across the three replications [47].

2.2. Aggressivity

Aggressivity (A) gives a simple measure of how much the relative yield increase in species "a" is greater than that for species "b". It also assumed that the mixture forms a replacement series. It was calculated using plant dry weight (stover and haulm dry weight) [49] and it was calculated according to the following formula [25]:

A = La – Lb

Where, La $= \frac{Mixture\,yield\,of\,a}{Expected\,yield\,of\,a}$

Lb = $\frac{Mixture\,yield\,of\,b}{Expected\,yield\,of\,b}$

Mixture yield of a = Yields of intercrop "a" in mixture with species "b"

Mixture yield of b = Yields of intercrop "b" in mixture with species "a"

Expected yield a , b = Corresponding sole crop yields of species a and species b, respectively.

3.10 Relative Competitive Abilities (RCA)

Competitive ratio gives a knowledge of the number of times one component crop is more competitive than the other. Grain LER was used in the calculation [26].

RCA(a) = $\left(\frac{PLER_{(a)}}{PLER_{(b)}}\right)$

RCA(b) = $\left(\frac{PLER_{(b)}}{PLER_{(a)}}\right)$

PLER = Partial land equivalent ratio

Zab = sown proportion of species a (sorghum) in mixture with species b (soyabean).

Zba = sown proportion of species b in mixture with a.

2.3. Statistical analysis

The data collected were subjected to statistical analysis of variance to test for significance of treatment differences [50]. The treatment means were partitioned using the standard procedure [51]. Land-use efficiency was quantified by the LER. Competitive abilities were estimated using coefficient of aggressivity and relative competitive abilities.

3. Results

3.1. Aggressivity

Aggressivity in sorghum as influenced by crop cultivar and crop row arrangement in 2008, 2009 and 2010 cropping seasons in a sorghum/soyabean intercropping system is shown in Table 1. The result showed that sorghum was less aggressive relative to soyabean in the crop row arrangements considered during the three years of experimentation. The combined result showed that SAMSORG-14 had higher (-0.30) aggressivity relative to SAMSORG-17 (-0.11).

The intercropped soyabean cultivars had similar aggressivity values with TGx 1448-2E and SAMSOY 2 producing -0.21 and -0.20, respectively. During the period of experimentation, 2SG:1SY crop row arrangement produced soyabean crops that were more aggressive in growth than the component sorghum. Following this most aggressive crop row arrangement was 1SG:1SY and then 2 rows of sorghum intercropped with 2 rows of soyabean. The crop row arrangement that showed the least sorghum aggressivity over the component crop was 1SG:2SY crop row arrangement. Among the treatment combinations, SAMSORG-17 intercropped with TGx 1448-2E in 2SG:1SY row arrangement was the most aggressive (0.28) followed by SAMSORG-17 intercropped with TGx 1448-2E in 1SG:1SY row arrangement (0.05) relative to other row arrangements.

3.2. Relative competitive ability (sorghum).

Shown in Table 2 is the effect of crop cultivar and crop row arrangement on relative competitive ability of sorghum in a sorghum/soyabean intercropping system during the 2008-2010 rain-fed seasons. There were differences in the effect of sorghum cultivars on relative competitive ability, with SAMSORG-14 producing higher (1.87) value relative to SAMSORG -17 (1.32). The effect of intercropped soyabean cultivars on the relative competitive ability showed that TGx 1448-2E had higher (1.77) value relative to SAMSOY 2 (1.42).

Crop row arrangement had effect on the competitive ability of sorghum with 2SG:1SY crop row arrangement exhibiting the highest (3.01) competitive ability of sorghum in the intercrop than 1SG:1SY crop row arrangement (1.43), which in turn was higher than 2SG:2SY crop row arrangement (1.17) and 1SG:2SY crop row arrangement (0.76). The treatment combinations showed that SAMSORG -14 intercropped with TGx 1448-2E in 2SG:1SY row arrangement had the highest (4.6) relative competitive ability followed by SAMSORG -14 intercropped with SAMSOY 2 in 2SG:1SY row arrangement (3.03) and SAMSORG -17 intercropped with TGx 1448-2E in 2SG:1SY row arrangement (2.40) in that order relative to SAMSORG -17 intercropped with TGx 1448-2E in 1SG:2SY row arrangement (0.49) that had the least relative competitive ability.

3.3. Relative competitive ability (soyabean)

The relative competitive ability of soyabean as affected by the two cultivars of sorghum and crop row arrangements in a sorghum/soyabean intercropping system during 2008-2010 rain-fed seasons is presented in Table 3. During the three years of experimentation, TGx 1448-2E had higher (0.91) relative competitive ability relative to SAMSOY 2 (0.85). Similarly, the effect of intercropped sorghum cultivars on relative competitive ability showed that SAMSORG -17 had higher (1.09) value than SAMSORG -14 (0.68).

There were differences in the effect of crop row arrangement on competitive ability of) soyabean with 1SG:2SY row arrangement having higher (1.54) value relative to SAMSOY 2 (0.85). Similarly, the effect of intercropped sorghum cultivars on relative competitive ability showed that SAMSORG -17 had higher (1.09) value than SAMSORG -14 (0.68).

There were differences in the effect of crop row arrangement on competitive ability of soyabean with 1SG:2SY row arrangement having higher (1.54) value relative to 2SG:1SY row arrangement that had the least (0.39).

Among the treatment combinations, SAMSORG -17 intercropped with TGx 1448-2E in 1SG:2SY row arrangement had the highest (2.24) relative competitive ability while SAMSORG -14 intercropped with TGx 1448-2E in 2SG:1SY combination had the least (0.25).

3.4. Land equivalent ratio.

The effect of crop cultivar and crop row arrangement on land equivalent ratio during 2008 - 2010 rain-fed seasons is presented in Table 4. SAMSORG -14 had higher (1.19) combined land equivalent ratio relative to SAMSORG -17 (1.12). The effect of intercropped soyabean cultivars showed that TGx 1448-2E (1.14) had similar land use efficiency relative to SAMSOY 2 (1.16).

Intercropping sorghum and soyabean in 1:1 row arrangement resulted in higher (1.27) land equivalent ratio relative to the remaining row arrangements. Among the treatment combinations, SAMSORG -17 intercropped with TGx 1448-2E in 1:1 row arrangement had the highest (1.41) land equivalent ratio followed by SAMSORG -14 intercropped with SAMSOY 2 in 2:1 row arrangement (1.34) whereas SAMSORG -17 intercropped with TGx 1448-2E in 1:2 row arrangement gave the least LER of 0.98.

4. Discussion

The higher aggressivity (-0.09) recorded by soyabean in the 2SG:1SY crop row arrangement has shown that sorghum was less aggressive in spite of it's morpho-physiological characteristics due to reduced inter-plant competition. In a sorghum/soyabean trial, reported similar findings were reported in single alternate row arrangement (1:1) when compared to within row arrangement [52].

In this experiment, the highest relative competitive ability observed for sorghum (CRa) was at 2SG:1SY (3.01) crop row arrangements indicating that sorghum was dominant in this row arrangement. The sorghum cultivars were more competitive, presumably due to the high foraging capacity of the fibrous root system and the inherent waxy nature of the leaves that helps to reduce evapo-transpiration. However, for soyabean cultivars, the highest competitive ability (CRb) was in 1SG:2SY (1.54) crop row arrangement. The implication here is that no benefit of association for sorghum (CRa) had taken place at that (2SG:1SY) row arrangement unlike the 1SG:2SY (0.76) row arrangement that provided the benefit of association. Researchers [53] reported that positive benefit will take place where CRa is less than one (<1) and that of soyabean (CRb) is more than one (>1). Therefore, there is no benefit of association for sorghum/soyabean intercropped at 2SG:1SY crop row arrangement whereas, for sorghum/soyabean intercropped at 1SG:2SY row arrangement there was positive benefit of association. The result of CRa further corroborates the findings on aggressivity which showed that sorghum was most competitive in 2SG:1SY row arrangement. Similar findings were reported in the evaluation of sorghum – cowpea intercrop [27].

The 1SG:1SY crop row arrangement produced the highest combined total land equivalent ratio (LER) value which resulted in 28 percent yield advantage over the sole crop. This beneficial effects of intercropping may be attributed to less competition for growth resources and the eventual productivity by both crops.

Table 1: Aggressivity of sorghum relative to soyabean as influenced by cultivar and crop row arrangement at Samaru, Nigeria, between 2008- 2010 rain-fed seasons.

TREATMENT	**2008**			**2009**			**2010**			
SAMSORG 14 intercropped with SAMSOY 2	**LER a**	**LER b**	**A**	**LER a**	**LER b**	**Aggressivity**	**LER a**	**LER b**	**A**	**Mean**
1:1	0.74	0.86	-0.12	0.94	1.23	-.029	0.86	0.92	-0.06	-0.16
1:2	0.99	1.68	-0.69	0.74	1.16	-0.42	0.88	0.63	0.25	-0.29
2:1	0.87	0.95	-0.08	0.92	0.92	0.00	0.78	1.14	-0.36	-0.15
2:2	0.79	1;33	-0.54	0.65	1.22	-0;57	0.85	0.72	0.13	-0.33
SAMSORG -14 intercropped with TGx 1448-2E										
1:1	0.88	1.18	-0.3	1.05	1.51	-0.46	0;95	1.15	-0.2	-0.32
1:2	0.92	1.71	-0.79	0.97	1.71	-0.74	0.99	0.68	0.31	-0.41
2:1	0.61	1.25	-0.64	0.90	1.35	-.45	0.77	1.01	-0.27	-0.44
2:2	0.93	1.08	-0.15	0.78	1.07	-0.29	0.78	1.09	-0.31	-0.25
SAMSORG -17 intercropped with SAMSOY 2										
1:1	1.04	0.98	0.06	0.67	1.31	-0.64	0.82	0.81	0.01	-0.19
1:2	1.17	1.21	-0.04	0.72	1.29	-0.57	1.03	0.93	0.10	-0.17
2:1	0.83	0.88	-0.05	0.79	0.97	-0.18	0.81	0.66	0.15	-0.03
2:2	0.77	1.04	-0.27	0.84	0.73	0.11	0.91	1.09	-0.18	-0.11
SAMSORG -17 intercropped with TGx 1448 – 2E										
1:1	0.91	1.39	-0.48	0.85	0.42	0.43	0.89	0.68	0.21	0.05
1:2	0.92	1.33	-0.41	0.78	0.48	0.30	0.90	0.84	0.06	-0.02
2:1	1.21	0.70	0.51	0.87	0.54	0.33	0.82	0.83	-0.01	0.28
2:2	0.81	1.06	-0.25	0.62	0.55	0.07	1.04	1.10	-0.06	-0.08

Table 2: Relative competitive ability (RCA) of sorghum relative to soyabean in sorghum/soyabean intercrop as influenced by cultivar and crop row arrangement at Samaru, Nigeria, between 2008 – 2010 rain-fed seasons.

TREATMENT	2008			2009			2010			
SAMSORG 14 intercropped with SAMSOY 2	LER a	LER b	RCA	LER a	LER b	RCA	LER a	LER b	RCA	Mean
1:1	0.64	0.82	0.78	0.63	0.39	1.62	0.84	0.42	2.00	1.47
1:2	0.50	0.50	1.00	0.49	0.59	0.83	0.87	0.66	1.32	1.05
2:1	0.83	0.38	2.18	1.02	0.36	2.83	1.14	0.28	4.07	3.03
2:2	0.58	0.35	1.66	0.36	0.56	0.64	0.64	0.54	1.19	1.16
SAMSORG -14 intercropped with TGx 1448-2E										
1:1	0.76	0.61	1.25	0.70	0.43	1.63	0.80	0.35	2.29	1.72
1:2	0.53	0.76	0.70	0.40	0.68	0.59	0.60	0.54	1.11	0.80
2:1	0.85	0.31	2.74	0.84	0.21	4.00	1.27	0.18	7.06	4.60
2:2	0.47	0.42	1.12	0.46	0.74	0.62	0.63	0.40	1.58	1.11
SAMSORG -17 intercropped with SAMSOY 2										
1:1	0.76	0.83	0.92	0.38	0.47	0.81	0.73	0.47	1.55	1.09
1:2	0.35	0.61	0.57	0.62	0.65	0.95	0.33	0.65	0.51	0.68
2:1	0.93	0.38	2.45	0.51	0.40	1.28	0.63	0.27	2.33	2.02
2:2	0.64	0.58	1.10	0.31	0.84	0.37	0.52	0.49	1.06	0.84
SAMSORG -17 intercropped with TGx 1448 – 2E										

1:1	0.93	0.79	1.18	0.82	0.62	1.32	0.69	0.37	1.86	1.45
1:2	0.29	0.67	0.43	0.29	0.87	0.33	0.34	0.48	0.71	0.49
2:1	0.87	0.33	2.64	0.74	0.41	1.80	0.69	0.25	2.76	2.40
2:2	0.83	0.45	1.84	0.65	0.55	1.18	0.53	0.32	1.66	1.56

Table 3: Relative competitive ability (RCA) of soyabean relative to sorghum in sorghum/soyabean intercrop as influenced by cultivar and crop row arrangement at Samaru, Nigeria, between 2008 – 2010 rain-fed seasons

TREATMENT	2008			2009			2010			
SAMSORG 14 intercropped with SAMSOY 2	LER b	LER a	RCA	LER b	LER a	RCA	LER b	LER a	RCA	Mean
	0.82	0.64	1.28	0.39	0.63	0.62	0.42	0.84	0.5	0.8
	0.50	0.50	1.00	0.59	0.49	1.20	0.66	0.87	0.76	0.99
	0.38	0.83	0.46	0.36	1.02	0.35	0.28	1.14	0.25	0.35
	0.35	0.58	0.60	0.56	0.36	1.56	0.54	0.64	0.84	1.00
SAMSORG -14 intercropped with TGx 1448-2E										
1:1	0.61	0.76	0.80	0.43	0.70	0.61	0.35	0.80	0.44	0.62
1:2	0.76	0.53	1.43	0.68	0.40	1.70	0.54	0.60	0.90	1.34
2:1	0.31	0.85	0.36	0.21	0.84	0.25	0.18	1.27	0.14	0.25

2:2	0.42	0.47	0.89	0.74	0.46	1.61	0.40	0.63	0.63	1.04
SAMSORG -17 intercropped with SAMSOY 2										
1:1	0.83	0.76	1.09	0.47	0.38	1.24	0.47	0.73	0.64	0.99
1:2	0.61	0.35	1.74	0.65	0.62	1.05	0.65	0.33	1.97	1.59
2:1	0.38	0.93	0.41	0.40	0.51	0.78	0.27	0.63	0.43	0.54
2:2	0.58	0.64	0.91	0.84	0.31	2.71	0.49	0.52	0.94	1.52
SAMSORG -17 intercropped with TGx 1448 – 2E										
1:1	0.79	0.93	0.85	0.62	0.82	0.76	0.37	0.69	0.54	0.72
1:2	0.67	0.29	2.31	0.87	0.29	3.00	0.48	0.34	1.41	2.24
2:1	0.33	0.87	0.38	0.41	0.74	0.55	0.25	0.69	0.36	0.43
2:2	0.45	0.83	0.54	0.55	0.65	0.85	0.32	0.53	0.60	0.66

Table 4: The effect of crop cultivar and crop row arrangement on land equivalent ratio during 2008 – 2010 rain-fed seasons in a sorghum/soyabean intercropping system at Samaru, Nigeria.

TREATMENT	2008			2009			2010			
SAMSORG 14 intercropped with SAMSOY 2	LER a	LER b	TLER	LER a	LER b	TLER	LER a	LER b	TLER	Mean
1:1	0.64	0.82	1.46	0.63	0.39	1.02	0.84	0.42	1.26	1.25
1:2	0.50	0.50	1.00	0.49	0.59	1.08	0.87	0.66	1.53	1.20

2:1	0.83	0.38	1.21	1.02	0.36	1.38	1.14	0.28	1.42	1.34
2:2	0.58	0.35	0.93	0.36	0.56	0.92	0.64	0.54	1.18	1.01
SAMSORG -14 intercropped with										
TGx 1448-2E										
1:1	0.76	0.61	1.37	0.70	0.43	1.13	0.8	0.35	1.15	1.22
1:2	0.53	0.76	1.29	0.40	0.68	1.08	0.60	0.54	1.34	1.24
2:1	0.85	0.31	1.16	0.84	0.21	1.05	1.27	0.18	1.45	1.22
2:2	0.47	0.42	0.89	0.46	0.74	1.20	0.63	0.40	1.03	1.04
SAMSORG -17 intercropped with										
SAMSOY 2										
1:1	0.76	0.83	1.59	0.38	0.47	0.85	0.73	0.47	1.20	1.21
1:2	0.35	0.61	0.96	0.62	0.65	1.27	0.33	0.65	0.98	1.07
2:1	0.93	0.38	1.31	0.51	0.40	0.91	0.63	0.27	0.90	1.04
2:2	0.64	0.58	1.22	0.31	0.84	1.15	0.52	0.49	1.01	1.13
SAMSORG -17 intercropped with										
TGx 1448 – 2E										
1:1	0.93	0.79	1.72	0.82	0.62	1.44	0.69	0.37	1.06	1.41
1:2	0.29	0.67	0.96	0.29	0.87	1.16	0.34	0.48	0.82	0.98
2:1	0.87	0.33	1.2	0.74	0.41	1.15	0.69	0.25	0.94	1.10
2:2	0.83	0.45	1.28	0.65	0.55	1.20	0.53	0.32	0.85	1.11

Similar views have been reported in sorghum/soyabean intercrop which indicated a higher bio-economic efficiency. 1:1 crop row arrangement was recommended for grain yield in sorghum in the semi-arid savanna ecological zone of Nigeria [27].

In considering the competitive indices, the results of the present study have demonstrated the benefits of intercropping in the northern Guinea savanna of Nigeria. However, to achieve higher and sustainable productivity of sorghum/soyabean intercrop, SAMSORG-17 intercropped with TGx 1448-2E in 1SG:1SY row arrangement be adopted for the northern Guinea savanna.

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